Dec 19th, 12:00 AM

Corn Rootworm Management

Marlin E. Rice
Iowa State University, merice@iastate.edu

CORN ROOTWORM MANAGEMENT

Marlin E. Rice
Assistant Professor, Extension Entomologist,
Iowa State University

Three species of corn rootworms, the northern Diabrotica barberi, southern Diabrotica undecimpunctata howardi, and western Diabrotica virgifera virgifera, occur in Iowa corn. The northern and western species are capable of causing severe yield reductions. Because of this damage potential, soil insecticides are annually applied to more than 6 million acres of corn in Iowa. Not all fields have damaging populations of rootworm larvae and many would not require a soil insecticide.

Biology

The northern and western corn rootworms have similar life cycles. Female beetles lay their eggs in the top 8-12 inches of soil, usually in corn fields. The eggs overwinter in the soil and hatch the following June. If corn is planted in the same field, the hatching larvae will feed on corn roots during June and July. Larvae will not damage roots of other crops such as oats, sorghum, or soybeans.

Larvae are white with a brown head, brown tail plate on the top side of the last abdominal segment, and have 3 small pairs of legs. They range in size from a few millimeters when they first hatch, to a maximum length of 1/2 inch. After the larval stage is completed, the larva forms a pupa, which is a non-feeding stage that precedes the emergence of the adult beetle.

Beetles begin emerging in early July and emergence continues throughout August. Peak emergence occurs during late July and early August. Females begin laying eggs about two weeks after they have emerged and peak egg laying occurs from August 10-30. During late August and early September, beetles will congregate in fields where younger plants with green leaves or silks are still present. Egg-laying may be concentrated in these areas later in the season.

The larvae of the southern corn rootworm also feed on corn roots. This insect does not overwinter in Iowa but adults fly into the state from southerly locations during May and June. They will lay their eggs in corn fields but there are never enough in any one field to cause significant damage. However, they may contribute to the root injury created by the northern and western corn rootworms.

Recognition of Rootworm Injury

Small larvae will feed on the exterior root surface, small root hairs, and tunnel inside larger roots. Continued feeding by larger larvae may result in extensive tunneling and pruning of the major nodal roots, including brace roots. The impaired ability of injured plants to take up water and nutrients from the soil may result in physiological yield losses. Injured plants also may lodge as a result of the loss of support from the roots. After the larvae complete feeding and become pupae, the plants may regenerate roots and straighten up, resulting in gooseneck shaped stalks. Direct loss of ears and the added harvest costs of increased fuel and time are a result of lodging.

Research has been unable to demonstrate a consistent relationship between rootworm injury and yield reduction. Numerous factors influence the extent of the injury and the resulting impact upon yield. The number of larvae, size of the root system, availability of moisture and nutrients, root regenerative ability of the hybrid, and weather conditions are all factors that influence the loss of yield resulting from rootworm injury. When there is optimum moisture, nutrients, and plant populations, then severe root feeding may not result in significant yield loss, particularly if high winds do not cause lodging. If the moisture and nutrient levels are inadequate, it is likely that root feeding will be more directly related to yield losses.

Adults of all three species will feed on silks and pollen. If enough beetles emerge before pollination, the silk feeding may reduce pollination and seed set, resulting in partially barren ears. Silk feeding after pollination causes no damage.

Scouting Corn Rootworm Beetles

The objective of scouting corn rootworm beetle populations is to determine if enough beetles are present for the potential of economic damage by the larvae next summer. If populations in continuous corn fields exceed an average of 0.7 beetles per plant, this density may result in sufficient damage to warrant rotation to another crop or a planting-time insecticide if corn will be planted in the same field. There is a higher proportion of females present in first-year corn fields so the threshold is lowered to 0.4 beetles per plant in first-year corn.

The use of the sequential sampling method is recommended for both continuous (table 1) and first-year (table 2) corn fields. Begin sampling about August 1 and continue weekly through the first week of September, or until a management decision has been made. Late-planted or late-maturing fields may need to be scouted well into September.

The sampling technique used is called the "whole plant count" and simply involves counting all the beetles on a single plant. Avoid disturbing the beetles on the plant by approaching slowly, and observing beetles that are present on the leaves, tassels, and silks. The ear tip and silks should be grasped with one hand, while the upper and lower surfaces of each leaf, the tassel, and leaf axils should be examined for adult beetles. Finally, the ear tip should be examined for beetles hidden within the silks. Two plants should be sampled at each location, with the plants far enough apart so that counting beetles on one plant does not disturb the beetles on the second plant. The field should be scouted in a U-shaped pattern. The first pair of samples should be taken at least 50 paces into the field from the end rows; there should be at least 25 paces between each pair of samples.

After the beetles have been counted on 10 plants at 5 sites, consult the sequential sampling table for continuous corn (table 1) or first-year corn (table 2). As an example, if in continuous corn fewer than 3 beetles were counted, sampling may stop for that day and resume next week. If more than 11 beetles were observed, sampling may stop for the remainder of the season for that field because an economic population of beetles is present. Sufficient egg laying may occur to cause economic damage to corn the next year.

If, however, between 3 and 11 beetles are observed, additional plants must be sampled that day. After each additional pair of plants is sampled, consult the table again to determine if sampling may stop. This procedure continues until a decision can be made to stop because of either low or high beetle counts. If after 54 plants (at 27 sites) are sampled and a decision still cannot be made to stop (32 to 41 beetles are found), then sampling stops for that day and the field is resampled next week.

Management Strategies

Crop Rotation.

The most effective method of achieving corn rootworm control is by not growing corn where corn was grown the previous year. Many Iowa farmers have adopted a corn-soybean rotation and eliminated the use of a rootworm insecticide.

Every year the question arises, "Should a soil insecticide be applied to corn following soybeans?" Treating corn following soybeans for rootworms only results in an unnecessary expense of $9-12 per acre. You should not rely on general claims of probable need, possible increased yield, and "insurance claims" often observed in advertisements.

Extended Diapause.

For many years occasional, isolated fields of first-year corn have been damaged by corn rootworms. In 1985, damage was more widespread, occurring in widely separated localities in central and northwestern Iowa. It is now known that some northern corn rootworms have adapted to a corn-soybean rotation by exhibiting a two-year life cycle, instead of the more typical one-year cycle. Fortunately, in 1988 less than 15 percent of the first-year corn fields had economic damage from extended-diapausing northern corn rootworms. The western corn rootworm does not have an extended diapause cycle.

Growers in the affected areas who have had corn following soybeans damaged by rootworms in the past, or who farm adjacent to where such damage has occurred, should protect their 1990 crop with a rootworm insecticide.

Growers in central and northwestern Iowa who have not had the problem in a particular field are at very low risk. For example, a grower who has two fields 5 miles apart might be at high risk on the farm where damage occurred in 1988 but at low risk at the other location where damage has not occurred in the past. Use of a soil insecticide in fields where damage has not occurred is not recommended.

The northern corn rootworm generally comprises a minor portion of the total rootworm population in most of eastern and southern Iowa. Soil insecticides should not be used on corn following soybeans in these areas.

Insecticides at Planting.

Our present knowledge requires us to recommend that a rootworm insecticide be applied at planting on all fields of corn following corn with one exception. The exception is that if beetle scouting indicates that an insecticide is not needed.

For insecticides to be effective they must be applied at recommended rates, placed properly, and incorporated into the top inch of soil, although no insecticide will kill all rootworm larvae. Proper insecticide application should protect a zone of roots that will support the plant and provide the plant with nutrients and water.

Most insecticides are applied as granules in a 7-inch band just ahead of the press wheel. Banded applications usually give better rootworm control than in-furrow treatments with the same product. Liquid formulations of some products also are available and may be applied at the same rate as granules and covered with soil.

Calibrate application equipment often. Experience has shown that flowability of granules changes with fluctuations in humidity.

An untreated check strip of several rows should always be left in each field whenever a rootworm insecticide is used. Check rows allow insecticide performance to be evaluated. A suspected insecticide failure cannot be proven without untreated rows.

Insecticides at Cultivation.

All granular insecticides also may be applied during cultivation. They should be applied by June 15. Soil must be thrown to cover the granules. Iowa weather may not cooperate with cultivator applications, so in some years, continuous wet soil and weather may prevent cultivation and insecticide applications. Poor rootworm control also will occur during extremely dry conditions.

Adult Silk Clipping.

Adult beetle control is recommended if beetle feeding prevents the silks from emerging. The number of beetles required to prevent pollination from occurring will depend on the rate at which the silks are growing. Excessive heat and drought stress will retard silk growth. Under these conditions, 5 beetles per plant may be enough to interfere with pollination. Under normal conditions, as many as 15 beetles or more per ear may be required before pollination is diminished. If beetles are keeping the silks clipped and pollination is not complete, apply an insecticide to control the adults.

Factors Affecting Performance

Placement.

Insecticides can be applied directly into the open seed furrow, banded over the open seed furrow (commonly known as T-banding), or banded over the closed seed furrow. Research indicates that there are almost no differences in root ratings between these methods but T-banding does give, on the average, slightly better root ratings. All insecticides are labeled for banding and a farmer who uses banding equipment also has the flexibility of choosing from the broad array of products. If in-furrow equipment is used, then the products that can be used are limited to Counter, Force, and Furadan.

Enhanced Biodegradation.

This phenomenon occurs when a soil-applied pesticide is rapidly broken down by microorganisms, primarily bacteria. The result is a failure of the pesticide to adequately control the target pest because of decreased persistence in the soil. The problem usually appears in fields where carbamates have been used year after year. Of the products currently on the market, the carbamates (Broot and Furadan) have had the most rapid biodegradation. All insecticides have failed to prevent corn rootworm injury at one time or another, but no evidence has been found of decreased rootworm control and enhanced biodegradation for any of the currently used organophosphates (Aastar, Counter, Dyfonate, Lorsban, Mocap, and Thimet).

Strategies for managing the enhanced biodegradation problem are still being researched, but at the present time several options are available. First, rotate from corn to a different crop if possible. Second, if a soil insecticide is used, do not use a carbamate in successive years or when a previous problem with a carbamate failure has recently occurred. Consider using one of the organophosphates or a pyrethroid (Force). Third, make plans to scout for adult beetles this summer and avoid unnecessary insecticide usage the following year.

Insecticide and Soil Interactions.

Many additional factors can influence the effectiveness of the insecticide once it is incorporated into the soil. Insecticides vary both in their water solubility and vapor pressure, or volatility. Products with high volatility, such as Counter, Dyfonate, and Thimet may penetrate the soil more effectively than less-volatile insecticides. Soil moisture also can influence performance. Those with low water solubility often are more effective in dry soils, such as Furadan. Products with high solubility perform better in wet soils, such as Counter, Force, and Lorsban. Other factors such as pH, percentage organic matter, leaching, and toxicity also insecticide effectiveness. Most of these factors are beyond the influence of the farmer once the insecticide is in the ground.

Insecticide Evaluations

Root ratings are often used as a convenient method of evaluating the performance of an insecticide against corn rootworm larvae. The issue is still being debated as to what minimum root rating best reflects the threshold for economic damage. A root rating of 3.0 is often quoted as the threshold but 3.5 may be more realistic. In addition to rootworm feeding, there are many other interacting factors, such as soil moisture availability, root regrowth characteristics of the hybrid, fertility levels, soil type, etc. that also influence yields. Differences in root ratings below a 3.0 have little influence on yield differences. Therefore, root ratings are useful in evaluating insecticide performance but they do not accurately predict yield differences that result from root injury.

Below is the ISU root rating scale. It ranges from 1 (the least amount of injury) to 6 (the greatest amount of injury).

ISU Root Rating Scale

1 No noticeable feeding damage.
2 Feeding scars present but no root pruning.
3 At least one root pruned* but less than an entire node of roots pruned.
4 At least one full node of roots pruned* (partial nodes may be combined) but less than two full nodes.
5 At least two full nodes pruned* but less than three full nodes.
6 Three or more full nodes of roots pruned.

* To qualify as a pruned root, it must have been pruned to within 1 1/2" of the plant.

1989 Corn Rootworm Insecticide Tests*

Ames

Product	Rate/ 1000 ft.	Place- ment**	Root Rating	% Lodging
Lorsban 15G	8 oz.	A	2.45a	10.0ab
Dyfonate II 20G	6 oz.	A	2.50a	7.5a
Counter 15G	8 oz.	A	2.55a	20.0ab
Force 1.5G	8 oz.	A	2.60a	12.5ab
Mocap 15G	8 oz.	R	2.60a	10.0ab
Broot 15GX	8 oz.	A	2.70a	7.5a
Furadan 15G	8 oz.	A	2.70a	20.0ab
Force 1.5G	8 oz.	F	2.75a	15.0ab
Thimet 20G	6 oz.	A	3.00a	32.5 b
Counter 15G	8 oz.	F	3.05a	32.5 b
soybean meal	13.7 oz.	A	4.15 b	92.5 c
UNTREATED CHECK			4.29 b	91.0 c
soybean meal	13.7 oz.	F	4.45 b	90.0 c

Planted May 12, 1989. Insecticide history - no insecticide 1985 through 1988.

Atlantic

Product	Rate/ 1000 ft.	Place- ment**	Root Rating	% Lodging
Furadan 15G	8 oz.	A	2.50a	0.0a
Counter 15G	8 oz.	A	2.55a	0.0a
Dyfonate II 20G	6 oz.	A	2.90a	0.0a
Lorsban 15G	8 oz.	A	2.95a	2.5a
Counter 15G	8 oz.	F	3.05a	0.0a
Force 1.5G	8 oz.	A	3.15a	2.5a
Broot 15GX	8 oz.	A	3.25a	10.0a
Mocap 15G	8 oz.	R	3.40a	0.0a
Thimet 20G	6 oz.	A	3.45a	10.0a
Force 1.5G	8 oz.	F	3.55a	7.5a
UNTREATED CHECK			5.45 b	80.0 b

Planted May 15, 1989. Insecticide history - no insecticide 1985 & 1986; Counter 1987 & 1988.

Crawfordsville

Product	Rate/ 1000 ft.	Place- ment**	Root Rating	% Lodging
Furadan 15G	8 oz.	A	1.42a	0.0a
Broot 15GX	8 oz.	A	1.92ab	0.0a
Counter 15G	8 oz.	F	1.92ab	0.0a
Dyfonate II 20G	6 oz.	A	1.92ab	0.5a
Force 1.5G	8 oz.	A	1.92ab	0.0a
Mocap 15G	8 oz.	R	1.96 b	0.0a
Counter 15G	8 oz.	A	2.00 b	0.0a
Lorsban 15G	8 oz.	A	2.00 b	0.5a
Thimet 20G	6 oz.	A	2.00 b	0.0a
Force 1.5G	8 oz.	F	2.33 b	0.6a
UNTREATED CHECK			2.89 c	11.4 b

Planted May 16, 1989. Insecticide history - no insecticide 1985 through 1988.

Nashua

Product	Rate/ 1000 ft.	Place- ment**	Root Rating
Counter 15G	8 oz.	A	1.95a
Counter 15G	8 oz.	F	2.04ab
Furadan 15G	8 oz.	A	2.05ab
Dyfonate II 20G	6 oz.	A	2.10ab
Lorsban 15G	8 oz.	A	2.15ab
Force 1.5G	8 oz.	A	2.25abc
Mocap 15G	8 oz.	R	2.31abcd
Force 1.5G	8 oz.	F	2.45abcd
UNTREATED CHECK			2.84 bcd
Broot 15GX	8 oz.	A	2.85 bcd
Thimet 20G	6 oz.	A	2.85 bcd
soybean meal	13.7 oz.	F	3.05 cd
soybean meal	13.7 oz.	A	3.15 d

Planted May 9, 1989. Insecticide history - no insecticide 1986 & 1988; test plots 1985 & 1987.

Sutherland

Product	Rate/ 1000 ft.	Place- ment**	Root Rating
Counter 15G	8 oz.	A	1.80a
Force 1.5G	8 oz.	F	1.81a
Lorsban 15G	8 oz.	A	1.90a
Dyfonate II 20G	6 oz.	A	1.95a
Force 1.5G	8 oz.	A	1.95a
Broot 15GX	8 oz.	A	2.00a
Mocap 15G	8 oz.	R	2.10ab
Counter 15G	8 oz.	F	2.11ab
Furadan 15G	8 oz.	A	2.18abc
Thimet 20G	6 oz.	A	2.50abcd
soybean meal	13.7 oz.	F	2.90 bcd
UNTREATED CHECK			2.94 cd
soybean meal	13.7 oz.	A	2.99 d

Planted May 11, 1989. Insecticide history - no insecticide 1986 & 1988; test plots 1985 & 1987.
*Numbers in the same column are not statistically different, P>0.05, DMRT.
**A=T-banded ahead of press wheel; F=in furrow; and R=banded to the rear of the press wheel.